We claim:

1. A hydrofoil craft comprising at least one hull that lies at least mostly above water, a propulsion system, and at least one strut whose upper end is attached to the at least one hull and whose lower end is attached to a fully-submerged dynamically-lifting hydrofoil, the hydrofoil further comprising a leading edge and a trailing edge, a substantially continuous upper surface and a substantially continuous lower surface, a spanwise discontinuity in each surface near the leading edge for causing a local water boundary layer to separate from each surface, at least one gas source, a gas releaser behind the discontinuity on each surface for forming a cavity that extends rearward along each surface from the discontinuity to a cavity closure region near the trailing edge, a gas flow restrictor connected to each gas releaser for limiting gas released into each cavity and ensuring that each cavity closes ahead of the trailing edge, wherein pressure in the cavity on the upper surface is less than pressure in the cavity on the lower surface, wherein most of the upper and lower surfaces of the hydrofoil lie within the cavities, and wherein each surface in the cavity closure region is shaped for closing the cavity on that side relatively smoothly by minimizing a cavity contact angle between the cavity wall and the surface.
2. The hydrofoil craft of claim 1, wherein gas released into the cavity on the lower surface is pressurized below atmospheric pressure.
3. The hydrofoil craft of claim 1, further comprising at least one trailing edge flap positioned along at least a portion of the trailing edge.
4. The hydrofoil craft of claim 3, wherein a chord of the trailing edge flap is lengthened when the flap is lowered.
5. The hydrofoil craft of claim 3, further comprising outer trailing edge flaps that extend inward from vicinities of outer tips on lateral ends of the hydrofoil, and approximately fore-and-aft fences positioned on the upper and lower surfaces at inner ends of the outer trailing edge flaps for isolating adjacent spanwise gas cavities.
6. The hydrofoil craft of claim 5, further comprising an automatic motion control system connected to the outer trailing edge flaps for controlling vessel roll and pitch.
7. The hydrofoil craft of claim 5, further comprising inner trailing edge flaps positioned inboard of the outer trailing edge flaps.
8. The hydrofoil craft of claim 7, further comprising a gas duct inside the hydrofoil for supplying gas into the cavities.
9. The hydrofoil craft of claim 7, including upper and lower central fences located near centers of the upper and lower surfaces for isolating cavities on each side of the center, further comprising additional gas ducts inside the hydrofoil for releasing gas into additional isolated cavities.

10. The hydrofoil craft of claim 7, further comprising an automatic motion control system connected to the inner and outer trailing edge flaps for controlling vessel height above water.
11. The hydrofoil craft of claim 1, wherein the gas flow restrictor for at least one of the surfaces of the hydrofoil comprises a permeable wall through which gas must pass before being released into the cavity on at least one surface.
12. The hydrofoil craft of claim 11, wherein the permeable wall is a solid wall with holes that limit a gas flow rate.
13. The hydrofoil craft of claim 1, wherein the gas flow restrictor for at least one of the cavities on the hydrofoil comprises at least one valve through which the gas must pass before being released into the at least one cavity.
14. The hydrofoil craft of claim 13, further comprising an automatic control system connected to at least one valve.
15. The hydrofoil craft of claim 14, further comprising at least one sensor mounted on the craft for sensing cavity length or vessel speed, and connected to an input of the automatic control system.
16. The hydrofoil craft of claim 1, further comprising at least one fore-and-aft fence positioned along the surfaces for separating at least one of the cavities into multiple adjacent cavities, positioned on one or both surfaces of the hydrofoil.
17. The hydrofoil craft of claim 16, wherein the at least one fence comprises a thin plate.
18. The hydrofoil craft of claim 16, wherein the at least one fence comprises a strip of fully wetted flow.
19. The hydrofoil craft of claim 16, wherein the at least one fence comprises a fluid jet, with water or air, released from at least one of the surfaces.
20. The hydrofoil craft of claim 16, wherein the at least one fence extends a length of the cavity, and is either shorter or longer than a hydrofoil chord.
21. The hydrofoil craft of claim 20, wherein the gas releasers comprise plural gas jets for supplying gas to each adjacent cavity.
22. The hydrofoil craft of claim 20, further comprising a nose region of the hydrofoil extending aft from the leading edge to each discontinuity and a deflector for deflecting the nose region for changing hydrofoil geometry for control purposes.
23. The hydrofoil craft of claim 1, wherein a size of at least one of the cavities is changed by controlling geometry of a hydrofoil cross section.
24. The hydrofoil craft of claim 1, wherein a cavity contact angle significantly increases when one of the cavities closes beyond a desired cavity closure region.

25. The hydrofoil craft of claim 1, further comprising a wedge-like leading edge region having upper and lower aft ends, and wherein the upper and lower aft ends of the leading edge region comprise the upper and lower surface discontinuities.

26. The hydrofoil craft of claim 25, wherein surfaces of the leading edge region are curved.

27. The hydrofoil craft of claim 1, wherein the at least one gas source comprises air at atmospheric pressure, and pressure in the cavity on the lower surface is less than atmospheric pressure at a designed craft speed.

28. The hydrofoil craft of claim 1, further comprising at least one gas remover mounted near the trailing edge for removing gas from near an aft end of at least one of the cavities, a water separator connected to the at least one gas remover for separating water from the removed gas, and a recycler for recycling the removed gas.

29. The hydrofoil craft of claim 1, wherein the upper and lower surfaces in regions just ahead of the trailing edge are concave.

30. The hydrofoil craft of claim 1, wherein the hydrofoil is swept at least about 45 degrees forward or aft from a center.

31. The hydrofoil craft of claim 1, wherein the hydrofoil is swept at least about 70 degrees forward or aft from a center.

32. The hydrofoil craft of claim 1, further comprising at least one nose flap on each surface of the hydrofoil extending from a vicinity of the leading edge rearward to the discontinuity on each surface, wherein the at least one nose flap pivots outward from an axis lying close to the leading edge for controlling cavity thickness on each surface.

33. The hydrofoil craft of claim 32, further comprising an automatic control system for controlling the at least one nose flap for changing local hydrofoil lift.

34. The hydrofoil craft of claim 32, wherein each nose flap further comprises a flexible region near the leading edge for acting as a pivot, and wherein each nose flap further comprises an essentially rigid portion having a nose flap trailing edge which comprises the discontinuity.

35. The hydrofoil craft of claim 1, wherein the leading edge of the hydrofoil is swept either forward or back.

36. The hydrofoil craft of claim 1, further comprising a section of a trailing edge region that is replaceable.

37. The hydrofoil craft of claim 1, further comprising a one way valve at each gas releaser for preventing water from entering a gas supply system.

38. The hydrofoil craft of claim 1, further comprising retractors connected to the hydrofoil and the hull for retracting the hydrofoil.

39. The hydrofoil craft of claim 1, further comprising a take off mode controller for supplying additional gas to the cavity on the lower surface for permitting the cavity to extend beyond the trailing edge for increasing hydrofoil lift.

40. The hydrofoil craft of claim 1, further comprising one or more flaps connected to the hydrofoil for lowering and increasing hydrofoil lift for take off.

41. The hydrofoil craft of claim 1, further comprising at least one additional hydrodynamic lifting device mounted on the craft above the hydrofoil for increasing lift at take off.

42. The hydrofoil craft of claim 1, wherein a planform of the hydrofoil is tapered toward a tip on each end.

43. The hydrofoil craft of claim 42, wherein the taper approximates an ellipse.

44. The hydrofoil craft of claim 42, wherein local angle of attack of the hydrofoil reduces toward each tip.

45. The hydrofoil craft of claim 42, wherein the hydrofoil is swept either forward or back.

46. The hydrofoil craft of claim 45, wherein the hydrofoil resembles a delta foil.

47. The hydrofoil craft of claim 1, wherein a leading edge region that includes the leading edge varies in cross section along a span of the hydrofoil.

48. The hydrofoil craft of claim 47, wherein a trailing edge region that includes the trailing edge of the hydrofoil varies in cross section along the span.

49. The hydrofoil craft of claim 1, further comprising a generator connected to the craft and wherein air supplied to the cavity on the upper surface at a pressure lower than atmospheric pressure is used to generate power in the generator.

50. The hydrofoil craft of claim 1, wherein the hydrofoil has an up or down dihedral angle.

51. The hydrofoil craft of claim 1, wherein the hydrofoil comprises a main hydrofoil, and further comprising an additional hydrofoil mounted above the main hydrofoil for providing additional lift for take off and for improving operation in waves.

52. The hydrofoil craft of claim 1, further comprising a series of parallel ridges placed in the cavity closure region near a desired cavity closure location, wherein the ridges are angled to within 30 degrees of a water flow direction, and wherein cross sections of the ridges comprise a series of essentially symmetrical saw-tooth-like shapes.

53. The hydrofoil craft of claim 52, wherein the ridges are an outer surface of a film that is attached to the hydrofoil in the cavity closure region.

54. The hydrofoil craft of claim 52, wherein the saw-tooth-like shapes form a series of grooves in at least one of the upper and lower surfaces.

55. The hydrofoil craft of claim 52, wherein the saw-tooth-like shapes are u-shaped.

56. The hydrofoil craft of claim 1, wherein the hydrofoil comprises a main hydrofoil, and further comprising at least one tip hydrofoil added to each end of the main hydrofoil for reducing induced drag and for changing flow pattern near each end of the main hydrofoil.

57. The hydrofoil craft of claim 56, wherein at least one tip hydrofoil at each end is angled at least 45 degrees from horizontal.

58. The hydrofoil craft of claim 56, wherein at least one tip hydrofoil at each end is placed at an angle of attack for generate a vortex that spins opposite in direction to a tip vortex generated at each end by the main hydrofoil.

59. The hydrofoil craft of claim 56, wherein at least one surface of at least one tip hydrofoil has a closed cavity for reducing drag.

60. The hydrofoil craft of claim 1, further comprising a leading edge region adjacent the leading edge and a section of the leading edge region that is replaceable.

61. The craft of claim 1, wherein an above-water portion of the craft provides aerodynamic lift, and makes use of the water proximity for further increasing the aerodynamic lift by using a ground effect.

62. A hydrofoil craft comprising at least one hull that lies at least mostly above water, a propulsion system, and at least one strut having an upper end and a lower end, the upper end attached to the at least one hull and the lower end attached to a fully-submerged dynamically-lifting hydrofoil, the hydrofoil comprising a substantially continuous upper surface, a substantially continuous lower surface, a leading edge, a trailing edge, a wetted nose section on the lower surface that extends from the leading edge rearward to a spanwise lower discontinuity for causing a lower boundary layer to separate from the lower surface for forming a lower cavity rearward extending along the lower surface, wherein the nose section comprises an upper surface discontinuity for causing an upper water boundary layer to separate from the upper surface of the hydrofoil for forming an upper cavity rearward extending along the upper surface, at least one gas source, a gas releaser on each surface of the hydrofoil behind each discontinuity for forming the cavities that extend rearward, and a gas flow restrictor communicating with each gas flow releaser for ensuring that each cavity closes ahead of the trailing edge.

63. The hydrofoil craft of claim 62, wherein an angle of the nose section is adjustable.

64. The hydrofoil craft of claim 62, wherein each discontinuity comprises a relatively sharp convex corner.

65. The hydrofoil craft of claim 62, wherein the nose section is angled upward relative to water flow.

66. The hydrofoil craft of claim 65, wherein the nose section is angled approximately perpendicular to the water flow.

67. The hydrofoil craft of claim 62, further comprising at least one trailing edge flap having a trailing edge tab that rotates about an axis near a leading edge of the tab for helping to deflect the at least one flap.

68. The hydrofoil craft of claim 62, wherein the nose section is controllable over at least a portion of a span of the hydrofoil.

69. The hydrofoil craft of claim 62, further comprising a leading edge region having a section that is replaceable.

70. The hydrofoil craft of claim 62, further comprising a trailing edge region having a section that is replaceable.

71. The hydrofoil craft of claim 62, wherein gas is ducted from the lower cavity for supplying gas to the upper cavity.

72. The hydrofoil craft of claim 62, wherein the hydrofoil has an upward or downward dihedral angle.

73. The craft of claim 62, wherein an above-water portion of the craft provides aerodynamic lift, and makes use of water proximity for increasing the aerodynamic lift by using a ground effect.

74. A hydrofoil craft comprising at least one hull that lies at least mostly above water, a propulsion system connected to the craft, at least one strut having an upper end and a lower end, the upper end attached to the at least one hull, a fully-submerged dynamically-lifting hydrofoil attached to the lower end, the hydrofoil comprising an essentially continuous upper surface on a top of the hydrofoil, an upper trailing edge at an aft end of the upper surface, an essentially continuous lower surface on a bottom of the hydrofoil, and a lower trailing edge at an aft end of the lower surface, wherein the surfaces have a common leading edge, further comprising a spanwise discontinuity in each surface near the leading edge of the hydrofoil for causing a local water boundary layer to separate from each surface, at least one gas source connected to the craft, a gas releaser on each surface behind the discontinuity for forming upper and lower cavities that extend rearward, a gas flow restrictor for limiting a gas flow into the upper cavity for ensuring that the upper cavity closes ahead of the upper trailing edge on the upper surface, a gas supply connected to the lower surface for ensuring that the lower cavity on lower surface extends beyond the lower trailing edge on the lower surface, wherein pressure in the upper cavity on the upper surface is lower than pressure in the lower cavity on the lower surface, and wherein most of the upper surface of the hydrofoil lies within the upper cavity.

75. The hydrofoil craft of claim 74, wherein the lower surface includes a nose section with an aft edge and a nose leading edge comprising the leading edge of the hydrofoil, the nose leading edge acting as the discontinuity on the upper surface of the hydrofoil, and the aft edge of the nose section acting as the discontinuity on the lower surface.

76. The hydrofoil craft of claim 75, wherein the nose section is angled upward relative to a hydrofoil centerline that joins the leading edge and the upper trailing edge.

77. The hydrofoil craft of claim 76, wherein a region on the upper surface that extends forward from the upper trailing edge is angled upward at its front end relative to the hydrofoil centerline.

78. The hydrofoil craft of claim 77, wherein a portion of the region on the upper surface is concave in a direction of water flow.

79. A body comprising a low-drag surface-piercing elongated body having opposite sides and a symmetrical and essentially-continuous surface on each side, a leading edge, a trailing edge, an upper body region, a lower body region, an upper discontinuity for separating a water boundary layer near the leading edge in the upper region for forming a rearward-extending air-filled upper cavity on each side that is open to the atmosphere, a lower discontinuity for separating a water boundary layer near the leading edge in the lower region for forming a closed rearward-extending air-filled lower cavity that covers a majority of the surface in the lower region on each side, at least one generally horizontal fence for isolating the lower and upper regions, an air supply connected to the lower cavities, and an airflow restrictor for limiting airflow rate into the lower cavities for ensuring that the lower cavities close ahead of the trailing edge.

80. The body of claim 79, wherein a majority of the trailing edge in the upper region comprises a thick trailing edge, and wherein a majority of the trailing edge in the lower region is relatively sharp.

81. The body of claim 79, further comprising at least one adjustable trailing edge flap that comprises a trailing edge region of the body that extends ahead of the trailing edge over at least a portion of the trailing edge, wherein the flap is deflected for controlling side force.

82. The body of claim 81, wherein the trailing edge flap is quickly moved back and forth from nominal to full position for ensuring a time-averaged contact with a cavity wall on one side.

83. The body of claim 79, further comprising a nose flap on each side of the body, each nose flap having a trailing edge that comprises the discontinuity on that side, wherein each nose flap extends along at least a portion of a span of the body, and wherein each nose flap individually pivots outward from the body about an axis that lies close to the leading edge.

84. The body of claim 83, wherein each nose flap comprises a flexible region near the leading edge that acts as the pivot, and further comprises an essentially rigid portion whose trailing edge includes the discontinuity.

85. The body of claim 79, further comprising at least one above-water hull, a propulsion system, and a lifting hydrofoil that is attached near a lower end of the lower region of the body.

86. The body of claim 85, wherein the hydrofoil has upper and lower surfaces and an air cavity on the upper surface, and wherein pressure in the lower cavity on each side of the body is maintained close to pressure in the cavity on the upper surface of the hydrofoil.

87. The body of claim 85, further comprising an end region that lies immediately below the lower region of the body, wherein at least a majority of the end region is wetted on each side, and wherein the hydrofoil is attached near a bottom of the end region.

88. The body of claim 85, further comprising a debris cutter positioned at an intersection of the body and the hydrofoil.

89. The body of claim 79, further comprising holes in the fence, and wherein air is supplied to the lower cavities through the holes in the fence on each side for limiting airflow rate into the lower cavities.

90. The body of claim 79, wherein the leading edge of the body is swept at least 45 degrees fore or aft.

91. The body of claim 79, further comprising an air duct within the body, and wherein air is supplied to the lower cavities through holes from the air duct inside the body.

92. The body of claim 79, further comprising at least one additional discontinuity on each side in the upper region positioned aft of the discontinuity near the leading edge.

93. The body of claim 79, wherein the body is angled sideways from the vertical.

94. The body of claim 79, wherein the body is tapered in the downward direction.

95. The body of claim 79, wherein the body tapers downward and is swept fore or aft.

96. The body of claim 79, wherein the body has a yaw angle.

97. The body of claim 79, wherein the body telescopes in length.

98. The body of claim 97, further comprising at least one spring connected between telescoping parts of the body for reducing motion in waves, and a damper connected between telescoping parts of the body for damping the motion.

99. The body of claim 97, further comprising at least two such bodies wherein a height of at least one body is varied for turning.

100. The body of claim 79, wherein horizontal cross-sections of the body vary with depth.

101. A hull comprising an elongated low-drag hull having opposite sides, a propulsion system connected to the hull, a symmetrical and essentially-continuous side surface on each of the opposite sides, a leading edge, a trailing edge, a bottom surface, at least one source of pressurized air, multiple vertically-extending discontinuities lying between the leading edge and the trailing edge on each side surface for separating a water boundary layer and forming rearward-extending cavities open to the atmosphere, wherein at least a portion of the hull lies above the water surface, and further comprising at least one pressurized thin air cavity formed on the bottom surface for reducing frictional drag.

102. The hull of claim 101, further comprising an air ejector behind at least one of the discontinuities on each side.

103. The hull of claim 101 wherein the hull lies mostly under a water surface.

104. The hull of claim 101, wherein the hull lies essentially under a water surface, further comprising a thin surface-piercing member with an air duct inside connected to the cavities for providing air for the cavities, and an upper hull side surface having essentially transverse discontinuities for separating a water boundary layer for forming multiple air cavities on the upper side surface filled with air at less than depth pressure.

105. A hydrofoil craft comprising at least one hull that lies at least mostly above water, a propulsion system connected to the hull, at least one strut having an upper end attached to the hull and having a lower end, a fully-submerged dynamically-lifting hydrofoil attached to the lower end, the hydrofoil comprising an essentially continuous upper surface on a top of the hydrofoil and an essentially continuous lower surface on a bottom of the hydrofoil, wherein the upper and lower surfaces have a common leading edge and a common trailing edge, wherein the leading edge is swept at least 45 degrees forward or aft, at least one propulsion drive shaft connected to the propulsion system and located within the at least one strut, at least one essentially horizontal drive shaft connected to at least one propeller attached to at least one end of the at least one horizontal drive shaft.

106. The hydrofoil craft of claim 105, the at least one horizontal drive shaft further comprising at least one set of counter-rotating drive shafts connected to the propulsion drive shaft, at least one set of counter-rotating propellers attached to the at least one set of horizontal counter-rotating drive shafts.

107. The hydrofoil craft of claim 105, further comprising a set of anti-swirl vanes attached in line with the at least one propeller on either side of each propeller.

108. The hydrofoil craft of claim 105, wherein at least one of the propellers is superventilating.

109. The hydrofoil craft of claim 108, wherein the at least one superventilating propeller is ventilated with gas at less than atmospheric pressure.

110. The hydrofoil craft of claim 108, wherein a suction side of the at least one superventilating propeller has a closed cavity at less than depth pressure, and wherein a pressure side of the at least one propeller is superventilated at a pressure greater than that on the suction side.

111. The hydrofoil craft of claim 105, wherein at least one of the propellers is supercavitating.

112. The hydrofoil craft of claim 105, wherein at least one of the propellers is shrouded.

113. The hydrofoil craft of claim 105, wherein the blades of at least one of the propellers are highly swept.

114. The hydrofoil craft of claim 105, wherein at least one strut is swept at least 45 degrees.

115. The hydrofoil craft of claim 105, further comprising bearings and gearing for the drive shafts, and wherein gas used for superventilating each propeller is ducted along each drive shaft, and further serves to cool drive shaft bearings and gearing.

116. The hydrofoil craft of claim 105, further comprising a lower gearbox connected to the drive shaft and wherein the horizontal drive shaft and the lower gearbox are contained within a pod attached to the hydrofoil.

117. The hydrofoil craft of claim 105, further including an underwater sound transmitter attached to the craft for transmitting a sound beam forward of the craft for frightening sea animals away from a path of the hydrofoil.

7 118. A hydrofoil craft comprising at least one hull that lies at least mostly above water, a propulsion system connected to the hull, and at least one strut having an upper end attached to the hull and having a lower end, a fully-submerged dynamically-lifting hydrofoil attached to the lower end, the hydrofoil comprising an essentially continuous upper surface on a top of the hydrofoil and an essentially continuous lower surface on a bottom of the hydrofoil, wherein the hydrofoil surfaces have a common leading edge and a common trailing edge, wherein the leading edge of the hydrofoil is swept forward or aft at least 45 degrees, and wherein the propulsion system comprises at least one propulsion drive shaft connected to at least one propeller.

119. The hydrofoil craft of claim 118, wherein the at least one drive shaft is angled downward and rearward from the at least one hull.

120. The hydrofoil craft of claim 118, wherein the at least one propeller is an air propeller.

121. The hydrofoil craft of claim 118, wherein at least one of the hydrofoil surfaces has a closed gas cavity for reducing drag.

122. The hydrofoil craft of claim 118, wherein the at least one propeller is submerged and comprises propeller blades that have opposite sides and at least one closed gas cavity on at least one of the sides for reducing drag.

123. The hydrofoil craft of claim 122, wherein the at least one propeller has a closed cavity on each side for reducing drag.

124. The hydrofoil craft of claim 122, further comprising a pod attached to the hydrofoil wherein the propulsion system comprises at least one electric motor housed within the pod for powering the at least one propeller.

8 125. Apparatus for reducing drag comprising an essentially continuous underwater surface, a trailing edge of the surface, at least one discontinuity on the surface angled to water flow along the surface for separating a water boundary layer from the surface, at least one gas source, a gas releaser behind the discontinuity for forming a cavity that extends rearward on the surface from the discontinuity, a gas flow limiter connected to the gas releaser for limiting gas flow into the cavity for ensuring that the cavity closes ahead of a trailing edge of the surface without gas being artificially withdrawn from the

cavity, wherein the surface is shaped in a desired cavity termination region for a minimum of a cavity contact angle, wherein at least a portion of the surface that lies behind the desired cavity termination region is shaped for increasing the cavity contact angle in case the cavity extends beyond the desired termination region.

126. The apparatus of claim 125, wherein the discontinuity is a protuberance from the surface.

127. The apparatus of claim 126, wherein the protuberance is a plate extending outward from the surface at an angle to the surface.

128. The apparatus of claim 127, wherein the angle of the plate is controllable for changing a size of the cavity.

129. The apparatus of claim 128, wherein the angle of the plate is about 90 degrees to the oncoming water flow.

130. The apparatus of claim 127, wherein the plate is angled approximately perpendicular to the surface.

131. The apparatus of claim 130, wherein a height of the plate is controllable for changing a size of the cavity.

132. The apparatus of claim 125, wherein the discontinuity is an inward step in the surface.

133. The apparatus of claim 125, wherein the discontinuity is a relatively sharp convex angle in the surface.

134. The apparatus of claim 125, wherein the discontinuity is a slot through which gas is released.

135. The apparatus of claim 125, wherein at least a part of the portion of the surface lying behind the desired cavity termination region is concave in the direction of water flow.

136. The apparatus of claim 125, wherein the gas releaser comprises holes in the surface placed behind the discontinuity.

137. The apparatus of claim 136, further comprising an essentially rearward-facing flap placed over at least one of the holes.

138. The apparatus of claim 137, wherein the flap comprises a one-way valve for opening only when gas is released.

139. The apparatus of claim 125, wherein at least some of the gas is released within a region of the separated water boundary layer.

140. The apparatus of claim 125, wherein the gas flow limiter comprises a valve for controlling gas flow rate.

141. The apparatus of claim 125, wherein the gas flow limiter comprises a restriction in a duct for supplying gas to the cavity.

142. The apparatus of claim 125, further comprising a fence for separating adjacent gas cavities.

143. The method of reducing drag on an essentially continuous underwater surface comprising providing a surface discontinuity on the surface that is angled to water flow along the surface, separating a water boundary layer from the surface, providing at least one gas source, releasing gas behind the discontinuity, forming a cavity, extending the cavity rearward from the discontinuity, limiting gas flow rate into the cavity, ensuring that the cavity closes ahead of a trailing edge of the surface without gas being artificially withdrawn from the cavity, wherein providing the discontinuity comprises providing and angling the plate about 90 degrees to the surface.

144. The method of claim 143, further comprising controlling height of the plate and changing size of the cavity.

145. The method of closing a gas cavity comprising providing a moving underwater surface, providing gas to the surface, forming a gas cavity on the surface, providing a cross section of the surface transverse to water flow over the surface, providing a desired cavity closure in a cavity closure region, providing a series of substantially symmetrical saw-tooth-like shapes on the surface in a cross section of the cavity closure region.

146. The method of claim 145, wherein the providing the saw-tooth-like shapes comprises forming a series of parallel ridges in the cavity closure region and angling the parallel ridges to within 30 degrees of a water flow direction.

147. The method of claim 146, further comprising providing height of the ridges less than a maximum cavity thickness ahead of the cavity closure region.

148. The method of claim 147, wherein the providing the ridges comprises providing ridges on an outer surface of a film and attaching the film to the underwater surface in the cavity closure region.

149. The method of claim 145, wherein the providing the saw-tooth-like shapes comprises forming a series of grooves in the underwater surface and angling the grooves within about 30 degrees of the water flow.

150. The method of claim 145 further comprising providing each saw-tooth-like shape with sides deviating from straight lines.

151. The method of claim 145, wherein the providing saw-tooth-like shapes comprises providing u-shapes.

152. The method for reducing drag on a hydrofoil comprising providing a hydrofoil, providing an essentially continuous upper surface on a top of the hydrofoil, providing an essentially continuous lower surface on a bottom of the hydrofoil, joining the surfaces at a common leading edge and at a common trailing edge, providing a discontinuity, extending the discontinuity at least partially in a spanwise direction on at least one of the surfaces near the leading edge, separating a water boundary layer from the at least one of the surfaces, providing at least one gas source, releasing gas behind the

discontinuity, forming a gas cavity, extending the gas cavity rearward from the discontinuity, limiting gas flow rate into the cavity, closing the cavity ahead of the trailing edge, shaping the at least one of the surfaces in a desired cavity termination region for a minimum cavity contact angle, providing at least a portion of the at least one of the surfaces that lies behind the desired cavity termination region with a shape for increasing the cavity contact angle in case the cavity extends beyond the desired termination region.

153. The method of claim 152, wherein the providing a discontinuity comprises providing a protuberance from the at least one of the surfaces.

154. The method of claim 153, wherein the providing the protuberance comprises providing a plate extending outward from the surfaces at an angle to the surfaces.

155. The method of claim 154, further comprising angling the plate approximately perpendicular to the surface.

156. The method of claim 155, further comprising controlling height of the plate and changing size of the cavity.

157. The method of claim 154, wherein the angling of the plate comprises controlling the angling for changing size of the cavity.

158. The method of claim 152, wherein the providing of the discontinuity comprises providing an inward step in the at least one of the surfaces.

159. The method of claim 152, wherein the providing the discontinuity comprises providing a relatively sharp convex angle in the at least one of the surfaces.

160. The method of claim 152, wherein the providing the discontinuity comprises providing a slot and the releasing gas comprises releasing gas from the slot.

161. The method of claim 152, wherein the providing of at least a portion of the surface lying behind the desired cavity termination region comprises providing the at least a portion with a concave shape in a direction of water flow.

162. The method of claim 152, wherein the releasing gas comprises releasing gas into the cavity through holes in the surface behind the discontinuity.

163. The method of claim 162, further comprising providing an essentially rearward-facing flap over at least one of the holes.

164. The method of claim 163, wherein the providing the flap comprises providing a one-way valve and opening the valve only when gas is released.

165. The method of claim 152, wherein the releasing gas comprises releasing at least some of the gas within a region of the separated water boundary layer.

166. The method of claim 152, further comprising angling the discontinuity at about 90 degrees to water flow.

167. The method of claim 152, wherein the limiting comprises providing and controlling gas flow rate.

168. The method of claim 152, wherein the limiting comprises providing a restriction in a duct supplying gas to the cavity.

169. The method of claim 152, further comprising providing an adjacent gas cavity adjacent to the cavity and providing an approximately fore-and aft fence, and separating the adjacent cavity with the fence.

170. The method of claim 152, wherein the providing of a hydrofoil comprises providing a main hydrofoil providing at least one tip hydrofoil on each end of the hydrofoil and reducing induced drag and changing flow pattern near each end of the main hydrofoil.

171. The method of claim 170, further comprising wetting each surface of the tip hydrofoil.

172. The method of claim 170, further comprising providing a closed cavity on at least one side of each tip hydrofoil for reducing drag.

173. The method of claim 170, further comprising angling each tip hydrofoil at least 45 degrees from horizontal.

174. The method of claim 170, further comprising angling each tip hydrofoil at an angle of attack and generating a water vortex spinning in a direction opposite to a tip vortex generated by the main hydrofoil.

12 175. The method of reducing drag on a hydrofoil comprising providing an essentially continuous upper surface on a top of the hydrofoil, providing an essentially continuous lower surface on a bottom of the hydrofoil, providing the surfaces with a common leading edge and a common trailing edge, providing a spanwise discontinuity in each surface near the leading edge, causing local boundary layer, separating water flow from the surfaces, providing the lower surface with a spanwise nose section wherein the nose section provides the leading edge and provides the discontinuity on the upper surface of the hydrofoil, and providing a aft edge of the nose section which provides the discontinuity on the lower surface, providing at least one gas source, releasing gas behind the discontinuity on each surface forming cavities on the surfaces, extending the cavities rearward from the discontinuities, limiting gas flow rate into at least one cavity to ensure that it closes ahead of the trailing edge.

176. The method of claim 175, further comprising angling the nose section upward at a forward end thereof relative to a hydrofoil centerline.

177. The method of claim 176, further comprising providing a curve in a surface of the nose section.

178. The method of claim 176, wherein providing the nose section comprises providing an essentially flat spanwise plate and orienting the plate essentially perpendicular to approaching water flow.

179. The method of claim 175, further comprising providing a region on the upper surface extending forward from the trailing edge and angling the region upward relative to a hydrofoil centerline.

180. The method of claim 179, further comprising providing an aft portion of the region with a concave curvature.

181. The method of claim 175, further comprising providing the hydrofoil with a v-shaped planform, and sweeping the leading edge at least 45 degrees fore or aft.

182. The method of supplying gas into a gas cavity on a hydrofoil surface, comprising providing a lifting hydrofoil, providing a gas cavity on the hydrofoil, providing a gas source, flowing gas from the gas source through a spanwise duct in a strut that is attached to a hydrofoil, through at least one opening in the hydrofoil in a strut attachment region into a spanwise duct in the hydrofoil, and through at least one other opening in the hydrofoil into the cavity.

183. The method of claim 182, wherein the flowing of gas through the at least one other opening into the cavity flowing the gas through a one-way valve and preventing water from entering the hydrofoil duct.

184. The method of claim 183, wherein the flowing gas through the one-way valve comprises flowing the gas from under a flap that covers a hole and hinging the flap on an upstream side.

185. The method of claim 182, wherein the flowing comprises passing the gas from the spanwise duct in the hydrofoil through a permeable wall into a second spanwise duct in the hydrofoil before flowing the gas through the at least one other opening into the cavity.

186. The method of claim 185, wherein flowing through the permeable wall comprises flowing the gas through a porous material.

187. The method of claim 185, wherein flowing the gas through the permeable wall comprises flowing the gas through at least one hole in a solid wall.

188. The method of claim 182, wherein flowing the gas comprises flowing a portion of the gas through a permeable wall in one end of the spanwise hydrofoil duct into an extension of the spanwise hydrofoil duct before entering an opening into a second gas cavity on the hydrofoil surface.

189. The method of claim 182, further comprising providing gas flow rate into the cavity with a controller.

190. The method of claim 182, further comprising controlling a gas flow rate into the cavity with a pressure of the gas source and sizes of the openings.

191. The method of claim 182, wherein the providing the gas source comprises providing air at atmospheric pressure.

192. A hydrofoil method comprising supplying gas into gas cavities on the upper and lower surfaces of a hydrofoil, by flowing the gas from multiple gas sources through multiple spanwise ducts in at least

one strut that is attached to the hydrofoil, through multiple openings in the hydrofoil at strut attachment regions into multiple spanwise ducts in the hydrofoil, and through multiple openings in the hydrofoil into the cavities.

193. A hydrofoil craft comprising at least one hull that lies at least mostly above water, a propulsion system, at least one strut having an upper end attached to a hull and having a lower end, a fully-submerged dynamically-lifting hydrofoil attached to the lower end, an essentially continuous upper surface on a top of the hydrofoil and an essentially continuous lower surface on a bottom of the hydrofoil, wherein the surfaces have a common leading edge and a common trailing edge, further comprising a spanwise discontinuity on at least one of the surfaces near the leading edge for causing a local water boundary layer to separate, at least one gas source, a gas releaser behind the discontinuity for forming a cavity that extends rearward, a gas flow limiter for limiting a gas flow rate into the cavity for ensuring that the cavity closes ahead of the trailing edge, wherein most of the surface of the hydrofoil on the cavity side lies within the cavity, and wherein the hydrofoil craft further comprises a bow lifter positioned near a front of the craft for stabilizing the craft in at least heave and pitch.

194. The craft of claim 193, wherein the bow lifter comprises an inverted v-hydrofoil having foil tip regions for piercing a water surface at speed.

195. The craft of claim 194, wherein the inverted v-hydrofoil is superventilated on an upper surface.

196. The craft of claim 194, wherein the inverted v-hydrofoil is superventilated on a lower surface.

197. The craft of claim 194, wherein the inverted v-hydrofoil is swept back.

198. The craft of claim 193, wherein the bow lifter comprises a swept back v-hydrofoil that has negative dihedral and foil tip regions that pierce a water surface at speed.

199. The craft of claim 193, wherein the bow lifter comprises two surface-piercing v-hydrofoils.

200. The craft of claim 199, wherein at least one of two surfaces on each v-hydrofoil is superventilated.

201. The craft of claim 193, wherein the bow lifter comprises a set of side-by-side flexible planing plates wherein an angle of attack of each planing plate reduces as its lift increases.

202. A hydrofoil craft comprising at least one hull that lies at least mostly above water, a propulsion system, at least one strut having an upper end attached to a hull having a lower end, a fully-submerged dynamically-lifting v-hydrofoil in plan view attached to the lower end, the v-hydrofoil having leading edges swept at least 45 degrees, the craft further comprising a bow lifter positioned near a front of the craft for dynamically stabilizing the craft in at least heave and pitch.

203. The craft of claim 202, wherein the bow lifter comprises a swept back v-hydrofoil in plan view having negative dihedral and foil tip regions that pierce the water surface at a design speed.

204. A hydrofoil craft comprising at least one hull that lies at least mostly above water, a propulsion system, a dynamically-lifting hydrofoil for helping to lift at least most of a weight of the craft, the lifting hydrofoil comprising an essentially continuous upper surface on a top of the hydrofoil and an essentially continuous lower surface on a bottom of the hydrofoil, wherein the surfaces have a common leading edge and a common trailing edge, further comprising a spanwise discontinuity on at least a portion of at least one surface near the leading edge for causing a local water boundary layer to separate, at least one gas source, a gas releaser behind the discontinuity for forming a cavity that extends rearward, a gas flow limiter for limiting a gas flow rate into the cavity for ensuring that the cavity closes ahead of the trailing edge, an angled upward tip region at each end of the lifting hydrofoil for piercing a water surface and for attaching to the one or more above-water hulls.

205. The craft of claim 204, wherein the lifting hydrofoil leading edge is v-shaped in plan view, and is swept at least 45 degrees forward or aft.

206. The craft of claim 204, wherein at least a portion of the tip region is wetted on both sides.

207. The craft of claim 204, wherein at least a portion of the tip region is superventilated on one side.

208. The craft of claim 204, wherein at least a portion of the tip region has a closed cavity on one side.

209. The craft of claim 204, wherein at least one fence is positioned underwater in each tip region.

210. The craft of claim 204, wherein each tip region is lifting for dynamically stabilizing craft roll.

211. The craft of claim 210, wherein the tip regions also dynamically stabilize hydrofoil depth.

212. The craft of claim 210, wherein the hydrofoil leading edge is swept forward on each side and tip regions also dynamically stabilize craft pitch and depth.

213. The craft of claim 210, further comprising a hydrodynamic lifter at a bow of the craft for dynamically stabilizing the craft in pitch and depth.

214. A hydrofoil craft comprising at least one hull that lies at least mostly above water, a propulsion system, a dynamically-lifting hydrofoil for helping to lift at least most of the weight of the craft, the hydrofoil comprising an essentially continuous upper surface on a top of the hydrofoil and an essentially continuous lower surface on a bottom of the hydrofoil, wherein the surfaces have a common leading edge and a common trailing edge, a spanwise discontinuity on at least a portion of at least one of the surfaces near the leading edge for causing a local water boundary layer to separate, at least one gas source, a gas releaser behind the discontinuity for forming a cavity that extends rearward, a gas flow limiter connected to the gas releaser for limiting a gas flow rate into the cavity for ensuring that the cavity closes ahead of the trailing edge, a hydrofoil tip on each side of the hydrofoil, a strut attached inboard of a hydrofoil tip on each side for connecting the hydrofoil to the

one or more hulls, wherein each strut is angled from vertical, and wherein each strut provides lift for dynamically stabilizing the craft in roll.

215. The craft of claim 214, wherein each strut is angled outward from vertical for helping the craft bank inward when turning.

216. The craft of claim 214, further comprising a hydrodynamic lifter at a bow of the craft for dynamically stabilizing craft pitch.

217. A hydrofoil craft comprising at least one hull that lies at least mostly above water, a propulsion system, a dynamically-lifting hydrofoil for helping to lift part of the weight of the craft, the hydrofoil comprising an essentially continuous upper surface on a top of the hydrofoil and an essentially continuous lower surface on a bottom of the hydrofoil, wherein the surfaces have a common leading edge and a common trailing edge, a spanwise discontinuity on at least a portion of at least one of the surfaces near the leading edge for causing a local water boundary layer to separate, at least one gas source, a gas releaser behind the discontinuity for forming a cavity that extends rearward, a gas flow limiter connected to the gas releaser for limiting a gas flow rate into the cavity for ensuring that the cavity closes ahead of the trailing edge, wherein an above-water portion of the craft provides aerodynamic lift and makes use of water proximity for further increasing the aerodynamic lift by using a surface effect.

218. The craft of claim 217, further comprising an aft air stabilizer for aerodynamically stabilizing the craft in pitch.

219. The craft of claim 217, wherein a center of aerodynamic lift lies vertically near a center of gravity of the craft.

220. The hydrofoil craft of claim 217, wherein a plan form of the leading edge of the hydrofoil is v-shaped and is swept at least 45 degrees back or forward.